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Dangers of releasing CO₂ to fight fires in the cargo hold of seagoing bulk carriers

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On seagoing general cargo vessels, the cargo is stored in bulk in the holds. Fire protection for cargo holds comprises detection and firefighting capability. Detection normally incorporates a smoke sampling system that continuously draws air from each cargo hold and passes it to a smoke detector cabinet. The fire can be fought by flooding the cargo hold with inert carbon dioxide. The carbon dioxide is stored in its liquid form at pressures in excess of 50 bar and kept in multiple vertical steel cylinders arranged in a battery. For firefighting to be effective, SOLAS regulations require that a large fraction (80-90 percent) of the gas is delivered to the space of the cargo hold over a few minutes.

When discharged, the liquid carbon dioxide undergoes a change of phase to a mixture of gas and solid ("dry ice"). The sliding action of particles of dry ice can produce electrostatic discharges with sufficient energy to ignite flammable fuel/air mixtures. Because no vaporizer is present, considerable generation of static electricity is likely upon activation of the CO₂ extinguishment system and the large flow rate.

Certain biological materials carried in bulk, in particular wood pellets, can self-ignite and burn as an oxygen-deficient smoldering fire. Such fires produce flammable pyrolysis gases that can travel, accumulate and enter the explosive range. If carbon dioxide is released at this stage, a gas explosion in the cargo hold may result.

NFPA 12 on carbon dioxide extinguishing systems endorses the application of CO₂ to deep-seated fires involving solids subject to smoldering, but without identifying or alerting the reader to the potential presence of explosive pyrolysis gases. NFPA 12 appears to presume that electrostatic discharges will dissipate safely if metal nozzles are used and the entire system is grounded to earth. Lessons learned from past serious explosions appear to contraindicate this expectation.

In conclusion, the application of carbon dioxide is excellent for extinguishing a fire with flames but unsuitable for quenching a deep-seated smoldering fire without flame. If detection of fire in a cargo hold is based merely on presence of smoke, not detection of fire with flames, an activation of the CO₂ system may lead to explosion.

Keywords: bulk carrier, wood pellets, fire protection, CO₂, static electricity, explosion